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HOW TO KEEP YOUR MEMORY SAFE AND YOUR SOFTWARE FAST

PH.D. THESIS

Taddeüs Kroes

The research reported in this dissertation was conducted at the Faculty of Science, at the Department of Computer Science, of the Vrije Universiteit Amsterdam.

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HOW TO KEEP YOUR MEMORY SAFE AND YOUR SOFTWARE FAST

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad Doctor of Philosophy
aan de Vrije Universiteit Amsterdam,
op gezag van de rector magnificus
prof.dr. V. Subramaniam,
in het openbaar te verdedigen
ten overstaan van de promotiecommissie
van de Faculteit der Bètawetenschappen
op maandag 28 september 2020 om 15.45 uur
in de aula van de universiteit,
De Boelelaan 1105

door

Taddeus Kroes

geboren te Amsterdam

promotor: prof.dr.ir. H.J. Bos
copromotor: dr. C. Giuffrida

"This will be a very short project, I promise."

Cristiano Giuffrida, in 2016, 2017, 2018 and 2019.

Acknowledgements

Even though doing a Ph.D. is often a lonely journey, at the end of it I have many people to thank for being there along the way.

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In the last year of my Ph.D., I went on an internship at Google in New York. Although that has little to do with this thesis directly, I view my experience there as part of my Ph.D. journey and would like to take this opportunity to thank the people involved in making it an awesome one. László and Wei, thank you for supervising me and giving me so much freedom in my work. Stefan, I am happy to have gained you as a friend, and grateful for your professional guidance. Markus, thanks for showing me all the cool lunch spots! Franjo, thank you for showing me that managers can actually be a great influence.

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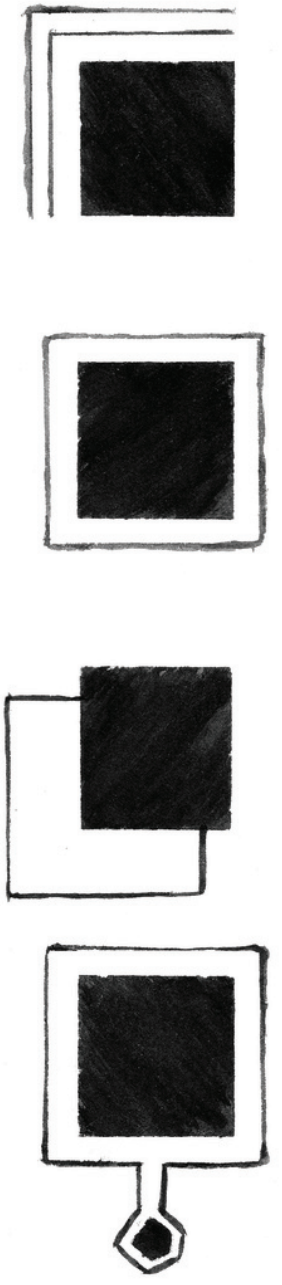
Taddeüs Kroes
Amsterdam, The Netherlands, August 2020



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Publications

This dissertation includes several research papers, as appeared in the following conference proceedings. The text differs from the published versions in minor editorial changes made to improve readability, and added clarifications to address comments by the committee:

Taddeus Kroes[1], Koen Koning[1], Erik van der Kouwe, Herbert Bos, and Cristiano Giuffrida. **Delta Pointers: Buffer Overflow Checks Without the Checks.** In *Proceedings of the Thirteenth EuroSys Conference (EuroSys '18)*, page 22. April 23-26, 2018, Porto, Portugal.
[Appears in Chapter 2]

Taddeus Kroes, Chris Ouwehand, Cristiano Giuffrida, and Herbert Bos. **RedPool: Slabifying Redzones for Efficient Spatial Memory Safety.** *Under review*
[Appears in Chapter 3]

Erik van der Kouwe, Taddeus Kroes, Chris Ouwehand, Herbert Bos, and Cristiano Giuffrida. **Type-After-Type: Practical and Complete Type-Safe Memory Reuse.** In *Proceedings of the 34th Annual Computer Security Applications Conference (ACSAC '18)*, pages 17–27. December 3-7, 2018, San Juan, Puerto Rico.
[Appears in Chapter 4]

Anil Altinay[1], Joseph Nash[1], Taddeus Kroes[1], Prabhu Rajasekaran, Dixin Zhou, Adrian Dabrowski, David Gens, Yeoul Na, Stijn Volckaert, Cristiano Giuffrida, Herbert Bos, and Michael Franz. **BinRec: Dynamic Binary Lifting and Recompilation.** In *Proceedings of the Fifteenth EuroSys Conference (EuroSys '20)*, pages 1–16. April 27-30, 2020, online virtual conference.
[Appears in Chapter 5]

[1]Equal contribution shared first authors.

Related publications not included in the dissertation are listed in the following:

Taddeus Kroes[1], Koen Koning[1], Cristiano Giuffrida, Herbert Bos, and Erik van der Kouwe. **Fast and Generic Metadata Management with Mid-Fat Pointers.** In *Proceedings of the 10th European Workshop on Systems Security (EuroSec '17)*. April 23, 2017, Belgrade, Serbia.

Taddeus Kroes[1], Anil Altinay[1], Joseph Nash[1], Yeoul Na, Stijn Volckaert, Herbert Bos, Michael Franz, and Cristiano Giuffrida. **BinRec: Attack Surface Reduction Through Dynamic Binary Recovery.** In *Proceedings of the 2018 Workshop on Forming an Ecosystem Around Software Transformation (FEAST '18)*, pages 8–13. November 15, 2019, Toronto, Canada.

Publications not related to this dissertation, but published in refereed conferences are listed in the following:

Lucian Cojocar, Taddeus Kroes, and Herbert Bos. **JTR: A Binary Solution for Switch-Case Recovery.** In *Proceedings of the International Symposium on Engineering Secure Software and Systems 2017 (ESSoS '17)*. July 4-5, 2017, Bonn, Germany.

[1]Equal contribution shared first authors.